Marine Vessel Emissions Inventory

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Presentation Outline

- Overview
- Marine Vessel Inventory Design and Development
- Summary of Emissions
- Conclusions

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Uses of Marine Vessel Inventory

- Amount, distribution, trends
- Identify and track control strategies
- Input to air quality modeling

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Previous Inventories

- Limited Area
- Assumptions
- Annual Average only
- No day-to-day variations

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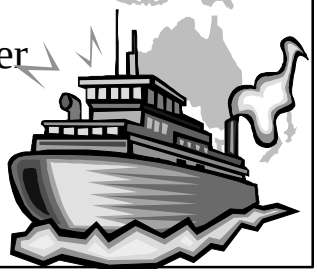
Pollutants Inventoried

NO_x - Oxides of Nitrogen
HC - Hydrocarbons
CO - Carbon Monoxide
SO_x - Oxides of Sulfur
PM - Particulate Matter



Technical Working Group

- California Air Resources Board
- U.S. EPA
- SCAQMD
- ARCADIS
- Ports of LA/LB
- U.S. Navy
- Pacific Merchant Shipping Association

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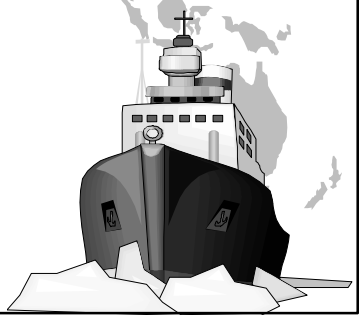
Approach

- Methods used
- Sources of data
- Assumptions
- Calculations
- Communication



Marine Vessel Emission Inventory Design

- Actual Shipping Activity
- Ship-Specific Engine Characteristics
- August 3-7, 1997
- 2 Km Grid Cell
- Southern California Waters in SCOS Domain

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Key Data Needs

SHIP ACTIVITY DATA

- Identification of Ship Modes of Operation
- Commercial Shipping Arrivals and Departures
- Maneuvering, Berthing and Hotelling
- U.S. Navy Vessel Inventory

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Key Data Needs

SHIP MACHINERY AND OPERATIONAL CHARACTERISTICS

- Ship-Specific Engine Characteristics
- Ship Speed
- Stack Information
- Engine Loads
- Emission Factors (Energy Output Based)

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Sources of Data

DATA	AGENCY
Commercial Ship Activity Data	ARCADIS, POLA, MAREX
Maneuvering, Berthing and Hotelling	Wharfinger Agencies, POLA, POLB
U.S. Navy Vessel Inventory	U.S. Navy, JJMA
Ship-Specific Engine Characteristics	JJMA
Ship Speed	MAREX, POLA
Stack Information	Pacific Merchant Shipping Association
Engine Loads	ARCADIS and JJMA
Emission Factors	ARCADIS, JJMA, and U.S.EPA

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Ship Operational Modes

MODE	DIRECTION
Cruise	Entry (Inbound)
Cruise	Exit (Outbound)
Precautionary Zone	Entry (Inbound)
Precautionary Zone	Exit (Outbound)
Maneuvering	Entry (Inbound)
Maneuvering	Exit (Outbound)
Hotelling	-

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Summary of Ship Activity During August Episode

Ship Type	Count
Bulk Carrier	9
Bulk/Container Carrier	3
General Cargo	3
Refrigerated Cargo	3
Passenger	3
Vehicle Carrier	6
Container Carrier	47
Chemical Tanker	1
Tanker	11
RORO Container	1
TOTAL	87

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Engine Characteristics

- Actual horsepower for each ship
- Slow speed versus medium speed
- Actual kW for each generator
- Steam ship-specific fuel consumption information
- Propulsion type emission factors

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Emission Factors

- Energy Output Based (grams per Kilowatt-hour)
- Main engines, Generators and Auxiliary Boilers
- Slow versus Medium Speed

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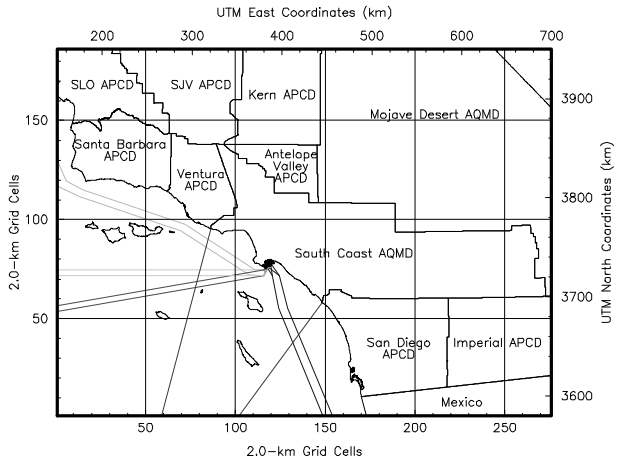
SCOS Domain



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Marine Vessel Emissions for August 3-7, 1997 Episode

Pollutant	Main Engines (Tons)	Generators (Tons)	Auxiliary Boiler (Tons)	Total (Tons)
NOx	79.5	27.9	8	115.4
HC	2.3	1	0.5	3.8
CO	7.3	3.3	1.5	12.1
PM	6.7	2.9	1.6	11.2
SOx	65.2	24.5	61.5	151.2

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NOx Emissions by Mode for August 3-7, 1997 Episode

Main Engines						Auxiliary Boilers		
Entry Cruise	Exit Cruise	Entry PZC	Exit PZC	Entry Manvg	Exit Manvg	Entry All Cruise	Exit All Cruise	Manvg + Hotelling NOx
31.5	38	3.1	2.6	2.3	2.0	0.2	0.2	7.5

Generators							Total NOx (tons)
Entry Cruise	Exit Cruise	Entry PZC	Exit PZC	Entry Manvg	Exit Manvg	Hotelling	
1.7	1.9	0.4	0.4	0.7	0.6	22.1	115.4

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Daily Variation in Marine Vessel Emissions-SCW

	Aug. 3	Aug. 4	Aug. 5	Aug. 6	Aug. 7	Total	Average TPD
NOx	26.1	30.2	15.1	18.7	24.6	115.2	23.0
HC	0.9	1.0	0.5	0.6	0.9	3.8	0.8
CO	2.7	3.2	1.7	2.0	2.5	12.1	2.4
PM	2.5	2.7	1.5	1.9	2.5	11.0	2.2
SOx	32.2	30.5	18.7	28.0	39.9	149.3	30.0

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Conclusions

- Key to the Project = Unprecedented access to marine vessel data + TEAMWORK
- Successful multi-agency approach leads to the development of a quality inventory
- Most comprehensive day-specific information collection
- Cooperative efforts needed between agencies & businesses

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Conclusions

- Majority of the marine vessel emissions occur during cruising and hotelling modes.
- Average NOx emissions during August 3-7, 1997 episode was 23 tons per day, with day-to-day variation.
- Average NOx emissions from U.S. Navy vessels during August 3-7, 1997 episode was 5 tons per day, with day-to-day variation.

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- T.L Garrett
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